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# Ophthalmologic Diseases of Small Mammals

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Ophthalmic examination of small mammals follows the same principles as in other species. Ophthalmic examination starts with evaluation of symmetry of globes and orbits. Evaluation of vision can be challenging because not all small mammals will have a consistent menace response. Evaluation of eyelids, conjunctiva, cornea, iris, and lens is best performed using a source of magnification and illumination. A slit-lamp biomicroscope is best suited for this, but use of an otoscope can provide magnification and illumination as well. The fundus is evaluated by direct or indirect ophthalmoscopy.

Tear production can be challenging to measure, depending on the species and size of the animal. In addition, a low tear production is present in some small mammals, leading to the use of different methodology to measure tear production. In larger animals, tear production can be determined by inserting a Schirmer tear test strip between the cornea and lower eyelid for 1 minute. However, the width of the strip is 5 mm, which is longer than the palpebral fissure in many small mammals. In the phenol red thread tear test, a 75-mm-long cotton thread, impregnated with pH-sensitive phenol dye, is inserted in the ventral conjunctival fornix.<sup>71</sup> After 15 seconds, the part of the thread that has changed to a red color is measured. This test is well tolerated and can be performed in species with very small eyes or low tear production.<sup>47</sup> The endodontic adsorbent paper point tear test measures the aqueous fraction of the tear film.<sup>43</sup> It uses sterile standardized paper cones or tips, originally developed for endodontics. The cones or tips are placed in the lower conjunctival fornix, and the amount of wetting is measured after 1 minute.<sup>43</sup> This test also is suitable for animals with small eyes or low tear production.

Intraocular pressure is measured by either applanation tonometry (MacKay-Marg®, Tono-Pen XL® [Reichert Technologies, Dewpew, NY], Tono-Pen AVIA® [Reichert Technologies]) or rebound tonometry (TonoVet®, TonoVet Plus®, TonoLab® [Icare, Vanta, Finland]). The Tono-Pen XL® is widely used. It

needs to be calibrated frequently. The Tono-Pen AVIA has a more ergonomic design, can be used in any position, and does not require calibration.<sup>67</sup> The advantage of the Icare TonoVet is that application of topical anesthetic to the eye is not required before use, and measurements can be obtained faster than with the Tono-Pen. Disadvantages are the need for the instrument to be in a vertical position and lack of calibration for certain species. Reference values for various diagnostic tests can be found in [Table 40.1](#).

## RABBITS

Ophthalmic examination of rabbits can be performed easily.<sup>90,91</sup> The eyes are laterally located and have a round pupil. Evaluation of a menace response is difficult, but most rabbits will react to bright light by squinting. The dorsal rectus muscle can usually be seen as a large striated band of tissue under the conjunctiva. Some rabbits do not respond to topical application of mydriatic agents because of the natural presence of atropinase. In these rabbits, adding topical 10% phenylephrine may help to obtain mydriasis. Rabbits have a merangiotic fundus. The well-myelinated optic nerve is present above the visual axis and has a deep optic cup ([Fig. 40.1A](#)). Retinal blood vessels are present in a linear streak medial and lateral to the optic nerve. An extensive venous plexus is present in the orbit.

The nasolacrimal system of rabbits has a single nasolacrimal punctum, which is located in the ventral eyelid 3 mm from the eyelid margin, near the medial canthus, and ventral to the lacrimal caruncle ([Fig. 40.2](#)).<sup>11,50</sup> The lacrimal sac is immediately rostral to the punctum and caudal to the nasolacrimal duct aperture. The nasolacrimal duct extends from the orbit to the nasal fossa and runs within the part of the maxilla that forms the lateral wall of the maxillary sinus.<sup>50</sup> Approximately 5 to 6 mm within the maxilla, the duct curves sharply and decreases

TABLE 40.1 Reference Values for Ophthalmic Diagnostic Tests in Small Mammals

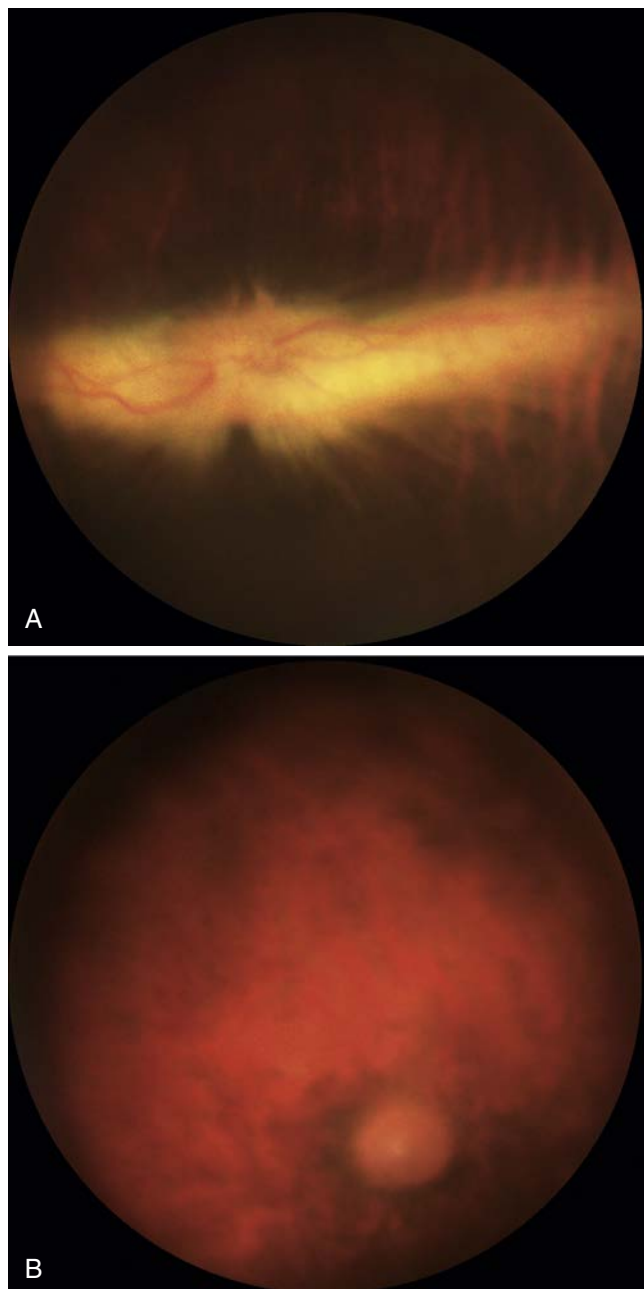
Species	Intraocular Pressure (mmHg)	Schirmer Tear Test (mm/min)	Phenol Red Thread Tear Test (mm/15 sec)	Endodontic Paper Point Tear Test (mm/min)
Chinchilla	2.9 ± 1.8 (TonoVet) <sup>61</sup> 17.7 ± 4.2 (Tono-Pen XL) <sup>47</sup>	Not reliable <sup>61</sup> 1.1 ± 0.5 <sup>47</sup>	14.6 ± 3.5 <sup>61</sup>	—
Ferret	22.8 ± 5.5 <sup>77</sup> 14.5 ± 3.3 <sup>58</sup>	5.3 ± 1.3 <sup>58</sup>	—	—
Guinea pig	16.5 ± 3.2 (Tono-Pen XL) <sup>97</sup>	3.8 ± 1.3 <sup>97</sup> Not possible <sup>84</sup>	—	—
Hamster	—	—	6.8 ± 2.5 <sup>71</sup> 5.1 ± 1.2 male <sup>71</sup> 8.5 ± 2.3 female <sup>71</sup>	—
Mouse	19.3 ± 0.4 <sup>94</sup>	—	—	4.4 ± 1.5 <sup>43</sup>
Rabbit	9.5 ± 2.6 (TonoVet) <sup>67</sup> 15.4 ± 2.2 (Tono-Pen Avia) <sup>67</sup> 9.7 ± 2.7 male (TonoVet) <sup>93</sup> 9.5 ± 2.2 female (TonoVet) <sup>93</sup>	5.2 ± 1.0 <sup>47</sup> 5 ± 2.4 <sup>1</sup>	—	13.8 ± 1.5 <sup>47</sup>
Rat	18.4 ± 0.1 <sup>94</sup>	—	—	6.2 ± 2.1 <sup>43</sup>

in diameter.<sup>11</sup> At the level of the palatine bone, the nasolacrimal duct leaves the bony nasolacrimal canal and makes a sharp turn at the nasolacrimal duct flexure, which is located just caudal to the caudal limit of the incisor tooth roots. The nasolacrimal duct narrows at this flexure in normal rabbits. The duct then follows the ventral margin of the nasoturbinates and exits on the ventromedial aspect of the alar fold just caudal to the mucocutaneous junction of the nares.

### Conjunctivitis and Epiphora

Conjunctivitis in rabbits is common. In normal rabbits with no ocular or respiratory disease, the most frequently isolated organisms from the conjunctival cul de sac are *Staphylococcus*, *Micrococcus*, and *Bacillus* species. *Pasteurella multocida* is a recognized cause of conjunctivitis, epiphora, nasolacrimal duct obstruction, and dacryocystitis in rabbits.<sup>25</sup> Less common organisms include *Bordetella*, *Stomatococcus*, *Neisseria*, *Pasteurella*, *Corynebacterium*, *Streptococcus*, and *Moraxella* species.<sup>16</sup> Other infectious agents that have been associated with conjunctivitis in rabbits are *Staphylococcus aureus*, *Pseudomonas* species, *Haemophilus* species, *Treponema paraluis-cuniculi*, mycoplasmas, chlamydiae, and myxoma virus.<sup>79</sup> In New Zealand white rabbits with conjunctivitis, upper respiratory disease, and pneumonia, bacterial isolates consisted of *Bordetella bronchepctica*, *P. multocida*, *S. aureus*, and *Pseudomonas alcaligenes*.<sup>63</sup> Mucopurulent conjunctivitis and blepharitis with corneal ulceration have been associated with *S. aureus* infection in a rabbit.<sup>57</sup> Treatment with topical gentamicin ophthalmic ointment and systemic gentamicin was curative. We have isolated a methicillin-resistant *S. aureus* in a rabbit with severe bilateral conjunctivitis. The strain isolated was identified as hospital acquired; the owner was a nurse in an urban hospital setting. Other causes of conjunctivitis in rabbits are foreign bodies, entropion, distichia, trichiasis, and high ammonia or dust content in the environment. Dental disease, including root elongation and dental abscesses, is also associated with conjunctivitis.

Unilateral or bilateral epiphora can be present in rabbits without conjunctivitis. The discharge often has a white, gritty appearance and may be intermittent and resistant to treatment with topical antibiotics. Root elongation of the maxillary incisors is a common underlying cause.<sup>25,33</sup> The elongated roots can cause an obstruction of the nasolacrimal duct at its flexure just caudal to the roots of the incisors. Radiographs or computed tomography (CT) scan of the skull are needed to assess the incisors; excess curvature of the incisor roots is abnormal. Dacryocystorhinography using contrast material injected into the nasolacrimal system can help localize the site of obstruction, differentiate between a complete and partial obstruction, and identify any dilation. In one report describing 2 affected rabbits and 13 normal rabbits, radiographs revealed a cystic dilation of the nasolacrimal duct immediately caudal to the duct flexure, and the incisors were more arched than in normal rabbits.<sup>50</sup> Irrigation of the nasolacrimal duct in affected rabbits yielded opaque, white, gritty fluid that, on cytologic examination, showed numerous macrophages, lipid-laden mesothelial cells, lipid droplets, and small numbers of bacteria and erythrocytes. Occlusion of the ducts was presumed to be attributed to fat droplets. Bacteriologic culture of fluids used to irrigate the nasolacrimal ducts of both normal and affected rabbits yielded similar bacterial isolates; therefore microorganisms may not be important in the pathogenesis of epiphora in rabbits. The most common bacterial isolates were *S. aureus*, coagulase-negative *Staphylococcus* species, *Moraxella* and *Neisseria* species, *Oligella urethralis*, and *Streptococcus viridans*. In a study of 28 cases of dacryocystitis in rabbits, 89% of cases were unilateral.<sup>25</sup> Of all cases, 50% were determined to be caused by dental malocclusion, 7% by rhinitis, 4% by both rhinitis and dental malocclusion, and 4% by panophthalmitis; no apparent cause was found in 35% of cases. Other ophthalmic abnormalities included conjunctivitis, nasal discharge, keratitis, periorbital swelling, and panophthalmitis. Bacterial culture of the fluid revealed the presence of one pathogen in four rabbits, two pathogens in two rabbits, and no growth was present in two rabbits. Most animals (98%)



**Fig. 40.1** Fundus examination of the rabbit and the guinea pig. (A) The fundus of the rabbit is merangioid. A horizontally ovoid disc is present with a horizontal zone of major vessels on both sides. The optic disc lies above the posterior pole of the eye. (B) The fundus of the guinea pig is classified as paucangioid. It appears avascular in most animals. The optic disc is white to gray. The fundus is a mottled red-brown in pigmented guinea pigs and appears diffusely reddish in white guinea pigs.

were treated with topical or oral antibiotics or both, with or without topical nonsteroidal antiinflammatory medications, with a mean duration of 5.8 weeks. Flushing of the nasolacrimal system with 0.9% NaCl solution was performed in most rabbits. The duct was patent in 12 rabbits and obstructed in 14 rabbits. Whether the nasolacrimal duct was patent or obstructed did not affect the disease outcome. In this study, 43% of rabbits improved with the obstruction resolved in an average of 2.9 weeks of treatment, 28% were euthanized, 11% died of unrelated causes, 11% were lost to

follow-up, and 7% had chronic dacryocystitis. The prognosis of animals with severe dacryocystitis requiring systemic therapy is guarded. The prognosis is also poor if any complications arise.

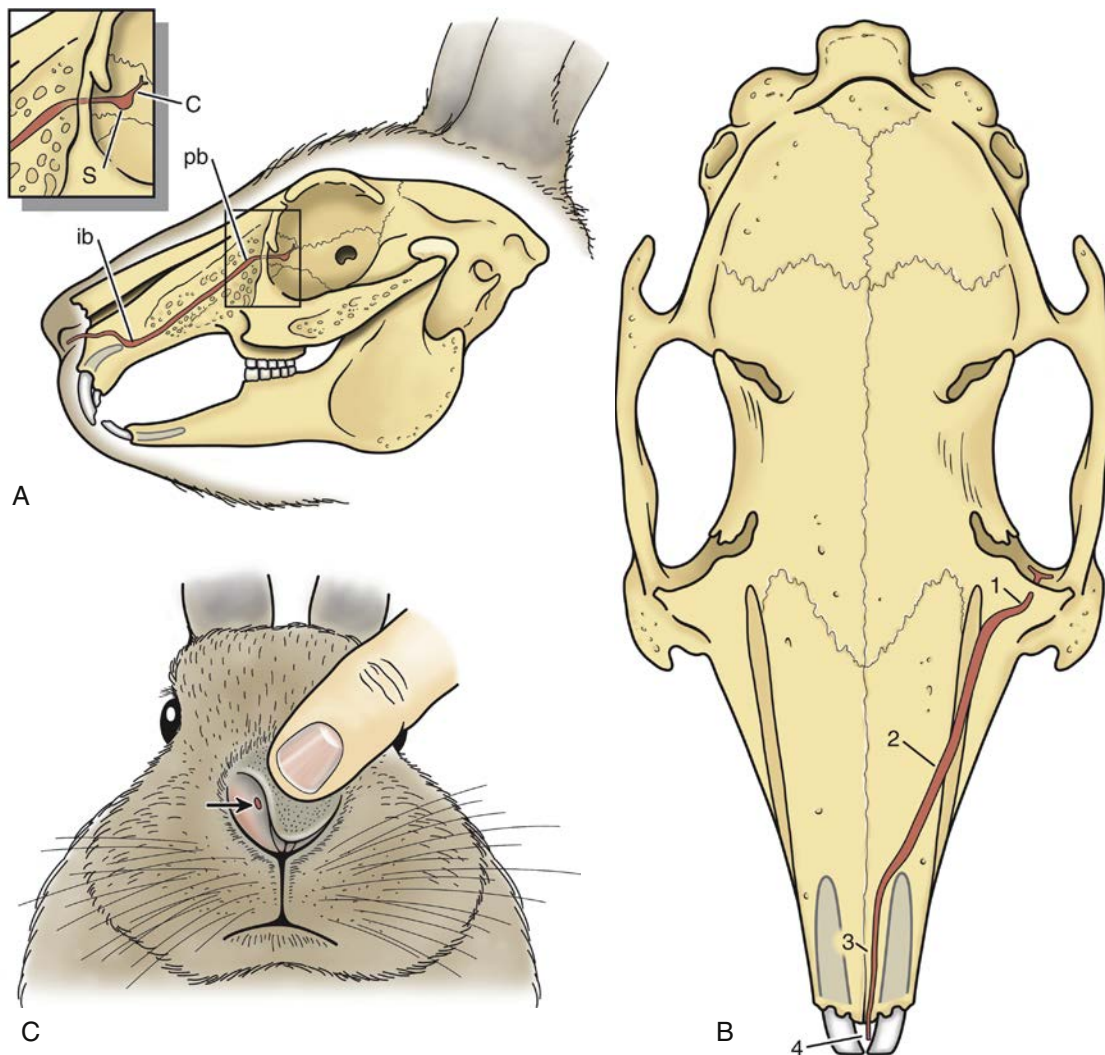
Treatment of epiphora in rabbits can be frustrating. The primary treatment is irrigation of the nasolacrimal duct, and this can be performed easily in rabbits. After instilling a topical ophthalmic anesthetic, insert a 23-gauge lacrimal cannula or a 22- to 24-gauge Teflon intravenous catheter into the nasolacrimal puncta in the medial aspect of the lower eyelid to flush the duct (Fig. 40.3). Recurrence of the obstruction is common, and duct irrigation may need to be repeated every 2 to 3 days or weekly until a few consecutive clear irrigations are obtained. If topical antibiotic therapy is used, a broad-spectrum medication such as triple antibiotic solution is recommended. Topical nonsteroidal, antiinflammatory ophthalmic medications, such as 0.03% flurbiprofen or 0.1% diclofenac, may help minimize irritation caused by the procedure. In rabbits with chronic or severe infections, concurrent topical ophthalmic and systemic antibiotic therapy may be needed. Suggested combinations include a systemic fluoroquinolone such as enrofloxacin or marbofloxacin and topical ciprofloxacin or gentamicin ophthalmic solution. In rabbits with evidence of underlying incisor root abnormalities or infection, removing the incisors can be considered in severe cases.

### Cornea

Corneal dystrophy is the accumulation of cholesterol or lipid crystals in the cornea.<sup>4</sup> This may develop spontaneously, as has been reported in American Dutch belted rabbits,<sup>59</sup> or be associated with high dietary cholesterol. It also occurs in breeds that are predisposed to hypercholesterolemia, such as the Watanabe rabbit with heritable hyperlipidemia.<sup>26,42</sup> In Watanabe rabbits, yellowish-white granules can develop along the corneal-scleral junction and in the iris. In rabbits without systemic lipid abnormalities, spontaneous corneal dystrophy is usually bilateral and symmetric and does not progress to visual impairment. In any rabbit with corneal dystrophy, carefully evaluate the fat content of the diet.

Progressive occlusion of the cornea with a conjunctiva-like membrane is occasionally seen in rabbits.<sup>3,21,75,78</sup> Membranous corneal occlusion, or pseudopterygium, is a pain-free condition that may affect one or both eyes (Fig. 40.4). Ophthalmic examination reveals a circular membrane that originates at the limbus (the junction of the cornea and sclera) and gradually advances over the cornea. In severe cases, only a small central opening is present, allowing visibility of an otherwise normal globe. The membrane does not adhere to the cornea. The cause of this condition is unknown, although trauma has been suggested. Progressive membranous occlusion in rabbits has been compared with pterygium in people. However, in people the membrane is triangular and adherent to the cornea, whereas in rabbits it is nonadherent and circumferential from the limbus. Treatment with topical antibiotic or antibiotic-steroid medications has no effect. The membrane can be resected surgically and treated with topical antibiotics; this usually results in quick recurrence of the membrane. However, if the membrane is resected a few millimeters beyond the limbus and the eye is then treated with a topical antibiotic-steroid combination, recurrence





**Fig. 40.2** Diagram of the rabbit nasolacrimal duct (A) Lateral view with inset. The two sharp bends, the proximal maxillary bend (*pb*), and the bend at the incisor tooth (*ib*), are indicated. The inset shows the canaliculus (*C*) and the lacrimal sac (*S*). (B) Dorsoventral view. (1) Proximal portion of the duct extending from the punctum through the proximal maxillary curve; (2) portion of the duct extending from the proximal maxillary curve to the base of the incisor tooth; (3) portion of the duct extending from the base of the incisor tooth to the end of the lacrimal canal; (4) distal portion of the duct extending from the end of the lacrimal canal to the nasal meatus. (C) The nasal meatus of the nasolacrimal duct (*arrow*). The opening is enlarged for diagrammatic purposes. (From Burling K, Murphy DJ, da Silva Curiel J, et al: Anatomy of the nasolacrimal duct and its clinical implications. *Prog Vet Comp Ophthalmol* 1991;1:33–40.)



**Fig. 40.3** Irrigation of the nasolacrimal duct in a rabbit with a 24-gauge Teflon intravenous catheter. Rabbits have a single nasolacrimal punctum in the ventral eyelid.



**Fig. 40.4** Progressive occlusion of the cornea with conjunctiva-like tissue. This tissue is not adherent to the cornea. The disease is not painful. (Courtesy David Wilkie, DVM, MS.)

may be prevented. Good results have also been obtained with surgical resection and the use of topical cyclosporine with or without corticosteroids.<sup>75</sup> Another described surgical technique is to incise the membrane into four to six quadrants and suture each quadrant of the membrane to the inside of the eyelid.<sup>3,78</sup> With this technique, recurrence may be prevented for at least 1 year.

Superficial, nonhealing corneal ulcers are occasionally seen in rabbits. Clinical signs are usually mild and include epiphora, conjunctival hyperemia, and blepharospasm. The ulcer is usually located in the paracentral cornea, is very superficial, and has redundant epithelial edges. The clinical appearance is that of an indolent ulcer, as seen in boxer dogs. If an ulcer is present, carefully examine the eye to eliminate potential causes such as abnormal hairs, lagophthalmos (inability to fully close the eyelid), facial nerve paralysis, or a foreign body. Treatment with a topical antibiotic solution or ointment usually fails to resolve the ulcer. Additional therapies such as corneal debridement, grid keratotomy, use of topical serum, application of corneal glue, tarsorrhaphy, or superficial keratectomy are usually necessary for the ulcer to heal.

Keratomycosis is described in rabbits. A corneal ulcer with white stromal infiltrates and a stromal abscess with dense hypopyon was reported in a 2-year-old female dwarf rabbit.<sup>9</sup> Fungal culture of the ulcerated area grew *Aspergillus fumigatus*. Treatment with 1% terbinafine ointment and 2% povidone iodine solution resulted in resolution of the ulcer and abscess in 8 weeks.

Eosinophilic keratitis is an inflammatory disease of the cornea that is most commonly diagnosed in cats. This condition was described in two rabbits that were presented with discharge, dacryocystitis, blepharitis, conjunctivitis, white plaques in the conjunctiva and cornea, and corneal vascularization. Cytologic examination and biopsy revealed the presence of eosinophils. Treatment of eosinophilic keratitis consists of a topical antibiotic-steroid combination (neomycin-polymyxin-dexamethasone) four times a day until the lesions resolve, followed by a slow taper.<sup>31</sup>

### Uveitis and Diseases of the Lens

*Encephalitozoon cuniculi* causes granulomatous encephalitis and renal lesions in rabbits. Many rabbits infected with *E. cuniculi* are asymptomatic, but neurologic signs can include convulsions, tremors, torticollis, paresis, and coma (see Chapter 18). *Encephalitozoon cuniculi* infection has also been associated with phacoclastic uveitis.<sup>23,28,82</sup> Most affected rabbits are young (less than 2 years of age), and dwarf rabbits appear predisposed to this disease. Clinically, a white mass is often seen protruding into the anterior chamber (Fig. 40.5). Careful examination of the anterior segment of the eye with slit-lamp biomicroscopy may reveal a break in the anterior lens capsule. The break is frequently hidden by inflammatory material, and it may appear as if only the iris is involved in the inflammatory process. A focal cataract is often present in the area of the anterior lens capsule break. Signs of a severe pyogranulomatous anterior uveitis are usually present, such as conjunctival hyperemia, a swollen



**Fig. 40.5** Rabbit infected with *Encephalitozoon cuniculi*. A white lesion is present in the iris, protruding into the anterior chamber. Lens involvement with cataract formation is present underneath the iridial lesion.

hyperemic iris, miosis, aqueous flare, and low intraocular pressure. The posterior segment of the eye is initially normal; however, if left untreated, severe uveitis and cataract formation can lead to blindness and possible phthisis bulbi or glaucoma. An abscess in the iris caused by *P. multocida* initially may resemble phacoclastic uveitis. Measurement of serum antibody titers for *E. cuniculi* and *P. multocida* may aid in the differential diagnosis. The treatment of choice is surgical removal of the lens by phacofragmentation. If an artificial lens is implanted, a 13-mm diameter, 58-Diopter intraocular lens is recommended.<sup>76</sup> Systemic treatment of *E. cuniculi* with albendazole (30 mg/kg orally every 24 hours for 30 days, then 15 mg/kg orally every 24 hours for an additional 30 days) has been reported.<sup>82</sup> Fenbendazole (20 mg/kg every 24 hours for 28 days) has proved effective in both preventing experimental *E. cuniculi* infection in rabbits and treating naturally infected seropositive rabbits.<sup>83</sup> If the lens is not removed surgically, control of the uveitis with topical steroidal (such as 1% prednisolone acetate) or nonsteroidal antiinflammatory medications, as well as systemic fenbendazole or albendazole, is necessary. Enucleation may be indicated if the uveitis cannot be controlled medically and a chronically painful eye is present.<sup>28,98</sup>

Cataract and subsequent glaucoma often can develop subsequent to ocular trauma, such as cat-scratch injury. Laceration of the cornea and anterior lens capsule by a sharp object results in formation of cataract often within weeks after the traumatic event. Exposure of the normally sequestered lens proteins may result in anterior uveitis. Secondary glaucoma or phthisis bulbi is common. However, spontaneous cataract formation is rare in rabbits. One report describes a low incidence of juvenile cataracts in laboratory New Zealand white rabbits.<sup>62</sup> Another report describes a high incidence of cataract in an inbred strain of New Zealand white rabbits. Virtually all inbred rabbits developed cataract after the age of 37 months, whereas no rabbits of an outbred strain developed cataract.<sup>66</sup> Keratitis caused by Shope fibroma virus has been reported in one rabbit.<sup>39</sup> Cataracts developed 3 months after the keratitis, which may have been hereditary in origin and unrelated to the virus.





**Fig. 40.6** Measurement of the intraocular pressure in a rabbit using a Tono-Pen. Compression on the neck and eyelids during restraint can artificially raise the intraocular pressure and should be avoided during measurement.

Persistent hyperplastic tunica vasculosa lentis with persistent hyperplastic primary vitreous was reported in a 3-month-old wild rabbit that presented for evaluation of cataract. This is a congenital abnormality.<sup>8</sup>

Intraocular sarcomas have been described in three adult rabbits; two had a nonvisual eye associated with chronic inflammation, and the second had chronic uveitis, cataract formation, and glaucoma.<sup>19,53</sup> In all rabbits, intraocular spindle cell neoplasms closely associated with lens and lens capsular fragments were described. The histologic features of the tumors closely resembled posttraumatic ocular sarcomas in cats; chronic inflammation and trauma were considered as probable causes.

### Glaucoma

Congenital glaucoma is inherited as an autosomal recessive trait in rabbits. In rabbits with this condition, the intraocular pressure is high as early as 3 months of age.<sup>12</sup> With increasing age, progressive buphthalmos with a markedly enlarged cornea, structural abnormalities of the iridocorneal angle, atrophy of the ciliary processes, and excavation of the optic nerve develop. Topical glaucoma medications used in dogs, such as 0.5% timolol maleate and 2% dorzolamide, may be used in rabbits. Because response to therapy is unpredictable in rabbits, carefully monitor the intraocular pressure during treatment (Fig. 40.6). Enucleation, insertion of an intrascleral prosthesis, and laser cycloablation with a diode laser have also been used to manage glaucoma in pigmented pet rabbits. However, laser cycloablation cannot be used in albino rabbits. If left untreated in chronic cases, pressure-induced atrophy of the ciliary body may cause the intraocular pressure to return to normal.

### Orbit

Retrolbulbar disease processes are occasionally seen in rabbits. Clinical signs are progressive exophthalmos, protrusion of the third eyelid, and inability to retropulse the globe. Exposure keratitis may be present if the ability of the eyelids to close properly has been affected. Abscesses are the common cause of retrolbulbar disease in rabbits; dental disease with tooth root abscessation is often a predisposing factor (see Chapter 36). Infection is caused by both aerobic and anaerobic bacterial species. A thorough dental examination and skull radiographs are indicated in any rabbit with a suspected retrolbulbar mass. If available, a CT scan is especially helpful in diagnosis. Abnormalities affecting the orbital bones and anterior ocular structures are predictive of neoplastic disease. Retrolbulbar neoplasia is uncommon in rabbits. Malignant B-cell lymphoma of the Harderian gland was diagnosed on postmortem examination in a rabbit with exophthalmos.<sup>89</sup> Abnormalities of extraconal fat and skin are suggestive of inflammatory disease.<sup>44</sup> In one report, *Taenia serialis coenurus* formation caused exophthalmos in a pet rabbit. Surgical removal was curative.<sup>64</sup>

An abscess in the retrolbulbar space of a rabbit can be very difficult to treat. Because of the thick nature of the abscessed material and the anatomy of the alveolar bulla, drainage of the abscess through the mouth, as performed in dogs and cats, may or may not be successful. A CT scan of the head is indicated to determine if tooth root abscessation is the underlying cause. If the abscess is caused by an abscessed tooth root, the tooth or teeth must be extracted to allow drainage, and the rabbit must be treated with long-term systemic antibiotic therapy. In some cases, aggressive surgical debridement is necessary. This may include exenteration of the orbit and sacrifice of a sighted eye. Even with aggressive surgical and medical management, the prognosis for recovery is always guarded. Stomatoscopy-aided dental trimming, tooth removal, and debridement successfully treated a retrolbulbar abscess in a rabbit.<sup>51</sup> Anecdotal reports suggest that some rabbits with retrolbulbar abscesses respond to medical therapy with long-term (3-month) administration of benzathine/procaine penicillin G (for rabbits <2.5 kg, 75,000 U per rabbit subcutaneously every 48 hours; for rabbits >2.5 kg, 150,000 U per rabbit subcutaneously every 48 hours).<sup>74</sup>

Bilateral exophthalmos in rabbits is commonly associated with compromised vascular drainage of the head. Periodic exophthalmos is common in rabbits with thymomas (see Chapter 20).<sup>41,68,87</sup> In one report, a localized myasthenia gravis associated with the thymoma was suggested as a cause.<sup>87</sup> More probably, the presence of a large intrathoracic mass, such as a thymoma, causes cranial vena caval syndrome, in which the mass compresses vessels in the cranial thorax.<sup>54</sup> This compression impedes blood flow in the right and left cranial vena cava as well as the external jugular veins and causes decreased vascular drainage from the head. Exophthalmos was also reported in a rabbit after the long-term placement of an external jugular catheter,<sup>36</sup> and bilateral exophthalmos can develop with thrombosis of both jugular veins. The external jugular veins are the largest vessels draining the head, whereas the internal jugular veins of rabbits are relatively small and primarily drain the brain, throat, and neck regions. Therefore occlusion of the external jugular veins will

compromise vascular drainage of the head. In clinical cases, exophthalmos secondary to venous thrombosis often resolves spontaneously, presumably after the jugular veins become patent again. Exophthalmos in obese rabbits may be caused by excessive fat deposition in the orbit. Simultaneous retropulsion of both globes should be avoided during ophthalmic examination, as a decrease in heart rate can occur in conscious rabbits.<sup>27</sup>

Rabbits have several glands in the orbit. The lacrimal gland is located dorsolaterally, and the accessory lacrimal gland, divided into three lobes, is located along the caudal and ventral orbital margin. The superficial gland of the third eyelid is a small gland located near the third eyelid's cartilage. The deep gland of the third eyelid, also known as the Harderian gland, consists of two parts: dorsal (white) and ventral (pink) lobes.<sup>34</sup> Enlargement of the Harderian gland may occur in orbital disease because of inflammation of the gland or obstruction of the excretory ducts.<sup>34</sup> Prolapse of the deep gland of the third eyelid has been described in rabbits. Surgical correction with a pocket technique, as has been described in dogs, was successful in reducing the gland in one rabbit.<sup>38</sup>

## FERRETS

Ferrets have prominent globes placed laterally in the skull; they have very limited binocular vision.<sup>29</sup> The ferret's pupil is a horizontal slit that quickly responds to light. Topical 1% tropicamide may need to be applied to evaluate the fundus. Like dogs and cats, ferrets have a holangiomatic retinal vascular pattern. The projection of retinal ganglion cells from the temporal area of the retina in albino ferrets differs from that of pigmented ferrets.<sup>60</sup> In pigmented ferrets, 6000 retinal ganglion cells project ipsilaterally to the brain, whereas in albino ferrets, only 1500 retinal ganglion cells project ipsilaterally. The significance of this difference has not been established.

Conjunctivitis in ferrets can be caused by viral or bacterial infection. Ocular signs of canine distemper virus, a fatal disease in ferrets, are mucopurulent oculonasal discharge, blepharitis, corneal ulcers, and keratoconjunctivitis sicca.<sup>40</sup> Conjunctival swelling and a proliferative lesion of the nictitans caused by infection with *Mycobacterium genavense* have been described in two ferrets. Other clinical signs in these ferrets included peripheral lymph node enlargement.<sup>49</sup>

Degeneration of corneal endothelial cells leading to progressive corneal edema and cloudiness of the cornea is seen in older mink (8–11 years of age).<sup>32</sup> Royal pastel females are predisposed. Unlike the disease in dogs, these mink do not develop corneal ulceration, pigmentation, or vascularization. There is no specific treatment for this condition, but symptomatic treatment with 5% sodium chloride solution or ointment two to four times a day may or may not improve corneal clarity.

A lymphoplasmacytic keratitis has been reported in a ferret with lymphoma.<sup>73</sup> An infiltrative lesion resembling corneal lesions reported in mink with Aleutian disease was present in the cornea.

Cataracts are common in ferrets.<sup>86</sup> Progressive cataract formation has been reported in two genetically unrelated populations of laboratory ferrets.<sup>55</sup> In 1-year-old ferrets in

one population, cataracts were observed in 47% of animals examined. Severity ranged from clinically insignificant, small cataracts in the posterior cortex of the lens to blinding, complete cataracts. By 18 months of age, cataracts were detected in virtually every animal, and in animals previously diagnosed, the cataracts had progressed. A genetically separate group had a combination of blinding cataract, microphthalmos, abnormal iris formation, and retinal detachment. In another ferret colony, microphthalmos, cataract, retinal dysplasia, and a persistent hyperplastic primary vitreous-type membrane were shown to be inherited as an autosomal dominant defect.<sup>20</sup> Dietary factors may play a role in the development of cataracts in ferrets. A diet high in fat or deficient in vitamin E or protein may promote cataract formation.<sup>55</sup> In ferrets with cataracts, monitor the eyes regularly for the onset of secondary complications. Lens-induced uveitis can usually be controlled with topical 1% prednisolone acetate applied once or twice daily. Other complications caused by cataracts are lens subluxation or luxation and glaucoma. Ferrets that are blind because of cataracts usually adjust well in a home environment. However, cataract surgery can be performed successfully in ferrets. The lenses can be removed by phacofragmentation or by an extracapsular technique. Artificial lenses are not available in a size suitable for ferrets. Before cataract surgery, make sure the ferret becomes accustomed to frequent application of eye medications to facilitate easy treatment after surgery.

Retinal degeneration is seen in ferrets. Clinical signs are progressive loss of vision, which may not be noticed until the disease is advanced. Ophthalmic examination reveals mydriasis with a very poor pupillary light reflex. Cataracts may or may not be present. Retinal vascular attenuation and tapetal hyperreflectivity are seen in the fundus. There is no treatment for retinal degeneration.

Exophthalmos can develop in ferrets from several causes. Lymphosarcoma is a common disease in ferrets, and although orbital involvement has been reported in only two ferrets,<sup>53</sup> it is occasionally seen clinically. Exophthalmos is often the presenting complaint. Ophthalmic examination reveals unilateral or bilateral exophthalmos, decreased retropulsion of the globe, and protrusion of the third eyelid. Lagophthalmos may result in exposure keratitis with corneal ulceration and vascularization. In clinical cases, lymphosarcoma is usually present in other areas of the body. In the two ferrets described,<sup>42</sup> peripheral lymph nodes were affected in one ferret and involvement of the liver, spleen, intestines, kidneys, and adrenals was present in the other. Retrobulbar adenocarcinoma has been reported in one ferret,<sup>52</sup> and we have seen this clinically as a rare cause of unilateral exophthalmos.

In ferrets with exophthalmos, a CT scan of the head is the best method of diagnosing a retrobulbar mass and determining the extent of the lesion. Cytologic examination of a sample from the retrobulbar area obtained by ultrasound-guided fine-needle aspiration can confirm the diagnosis of neoplasia. However, this procedure can be difficult because of the limited size of the retrobulbar space. Instead, in cases of suspected orbital lymphosarcoma, diagnosis may be confirmed by obtaining samples





**Fig. 40.7** Conjunctivitis and keratitis in a guinea pig. Note the abundant mucopurulent discharge, corneal vascularization, and fibrosis.

for diagnostic tests elsewhere in the body, such as a fine-needle aspirate or wedge biopsy of an enlarged lymph node. In ferrets with lymphosarcoma, therapy is directed at treating the disease systemically with prednisone or chemotherapeutic agents. While treating the ferret for lymphosarcoma, temporary tarsorrhaphy may be necessary to protect the cornea if pronounced exophthalmos is present. If the corneal epithelium is intact, protect the eye with lubricating ophthalmic ointment applied two to four times daily. If an ulcer is present, treat with an antibiotic ophthalmic ointment, such as triple antibiotic or gentamicin ointment, applied three to four times daily. In cases of retrobulbar adenocarcinoma, treatment may include exenteration and radiation therapy.<sup>52</sup> Zygomatic salivary gland mucocele is another reported cause of exophthalmos in ferrets.<sup>56</sup> Fine-needle aspiration of a soft fluctuant swelling dorsotemporal to the eye yields a tenacious, blood-tinged fluid. Surgical excision is usually curative.

## GUINEA PIGS

Guinea pigs have a paucangiotic retina that appears avascular on examination (Fig. 40.1B). Their eyelids are open from birth, and they have a rudimentary third eyelid. Guinea pigs produce a very small amount of tears, and measurement of tear production by using commercially available strips is not possible.<sup>84</sup> The phenol red thread tear test is a better option to assess tear production in guinea pigs.

Conjunctivitis is common in guinea pigs (Fig. 40.7). One common cause is *Chlamydia caviae* (previously classified as *Chlamydia psittaci*),<sup>40</sup> which causes a self-limited disease manifesting as mild chemosis, ocular discharge, and follicle formation. Cytologic examination of a specimen from a conjunctival scraping may reveal intracytoplasmic inclusion bodies in epithelial cells. Treatment is generally considered unnecessary. Vitamin C deficiency in guinea pigs causes conjunctivitis with a flaky discharge. Treatment is directed at correcting the dietary deficiency.

Other causes of conjunctivitis are varied. A spontaneous outbreak of listerial keratoconjunctivitis has been reported in hairless guinea pigs.<sup>15</sup> Clinical signs ranged from serous lacrimation with hyperemic conjunctiva to purulent, ulcerative keratoconjunctivitis

with corneal neovascularization. *Listeria monocytogenes* was cultured from the ocular discharge. Treatment was not attempted. Blepharitis caused by dermatophyte infection may be seen in young guinea pigs.<sup>5</sup> Topical antifungal therapy is usually effective. Irritation from abnormal hairs causes conjunctivitis, irritation, and possibly corneal ulceration. Surgical resection is curative.

Causes of infiltrative or nodular disease of the eye are also varied. Lymphosarcoma is rare in guinea pigs but has been reported to infiltrate the cornea.<sup>81</sup> Lymphosarcoma should also be considered as a differential diagnosis of conjunctival masses in guinea pigs.<sup>2</sup> Another differential diagnosis for conjunctival nodules in guinea pigs is a syndrome known as “pea eye.” These nodules are protrusions of portions of the lacrimal or zygomatic glands and appear pale or pink. Treatment is not necessary because animals are usually not bothered by this condition. A large palpebral liposarcoma was diagnosed in a guinea pig. Treatment was not attempted.<sup>70</sup> A dermoid is a congenital lesion in which skin-like tissue is present in an abnormal location. Corneal and conjunctival dermoids have been reported in guinea pigs.<sup>65,92</sup>

Cataracts have been reported in guinea pigs.<sup>97</sup> Cataracts can be removed surgically, but the procedure is difficult because of the small size of the globe, the large size of the lens, and the difficulty of intubating a guinea pig for general anesthesia.

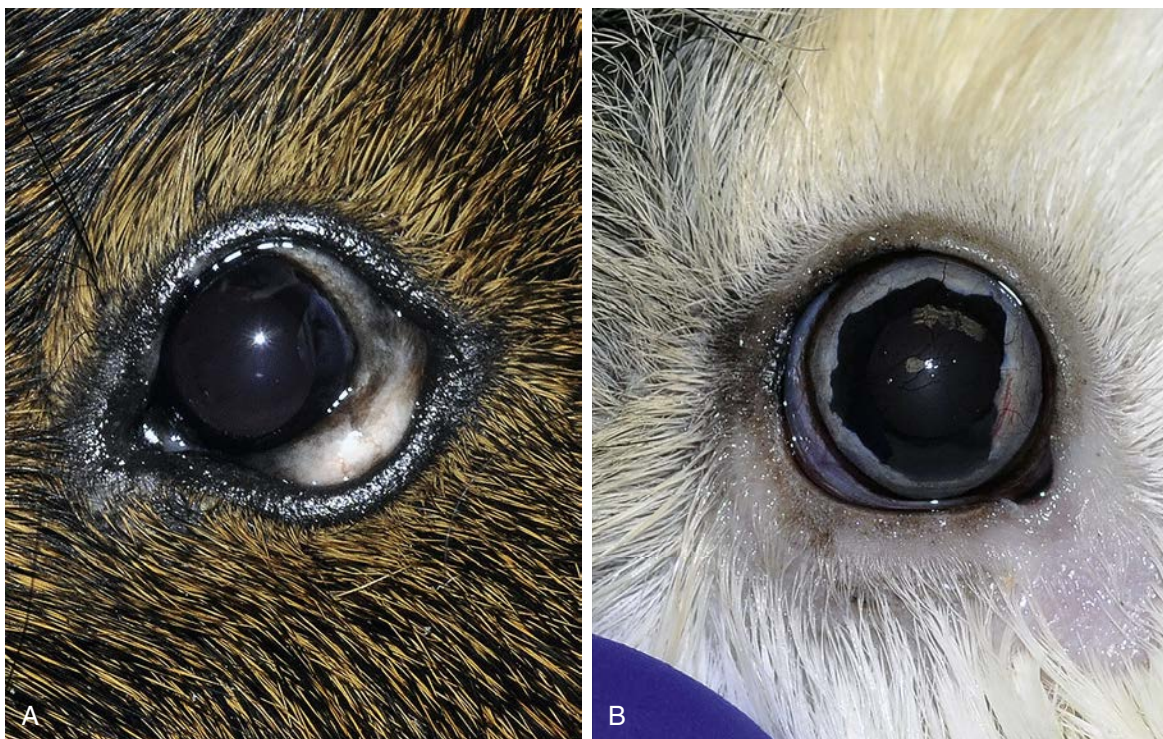
Osseous metaplasia of the mesectodermal trabecular meshwork occurs in guinea pigs (Fig. 40.8).<sup>10,30</sup> Clinically, an arc of white, opaque material is visible in the anterior chamber, covering the iridocorneal angle. Vessels may be present overlying the osseous choristoma. Hematopoietic active bone marrow is present. This is usually an incidental finding and no specific treatment is necessary.

As in other rodents and rabbits, exophthalmos in guinea pigs may be related to dental disease. A tooth root abscess of a molar may result in maxillary sinusitis and orbital disease. Careful examination of the teeth and a CT scan of the skull are indicated in any guinea pig with exophthalmos.

## CHINCHILLAS

Chinchillas have a vertical slit pupil and an anangiotic retina without a tapetum.<sup>45,61</sup> The optic disc can be myelinated or nonmyelinated, and focal cupping of the optic nerve is a normal finding. Most chinchillas do not have a menace or dazzle response. The orbit is shallow, and the globe proptoses easily. The third eyelid is rudimentary. Chinchillas have a Harderian gland, Meibomian glands along the length of both eyelids, a lacrimal gland in the temporal canthus, and two lacrimal puncta on the inner conjunctival surface of both eyelids near the medial canthus.<sup>88</sup> Cataracts and asteroid hyalosis have been reported in older animals.<sup>40</sup> Epiphora and conjunctivitis are commonly seen and often related to husbandry (see Chapter 22). The most common isolates from normal conjunctiva include *Streptococcus*, coagulase-negative *Staphylococcus* species, and *Staphylococcus aureus*.<sup>45</sup>

The premolar, molar, and incisor teeth in chinchillas, as in guinea pigs, continue to grow and erupt throughout the animal's life. Insufficient wear can result in elongated roots of the premolar and molar teeth, resulting in progressive orbital disease including epiphora, decreased retropulsion of the globe, and proptosis (see Chapter 36).<sup>18</sup> Computed tomography is more



**Fig. 40.8** Ophthalmologic conditions in guinea pigs. (A) protrusion from the inferior conjunctival sac or “pea eye.” (B) Heterotopic bone formation characterized by white lesions at the limbus. (Courtesy C. Mans.)

sensitive than radiography in detecting early lesions.<sup>17</sup> The prognosis for advanced disease is poor. Exophthalmos secondary to an orbital *Taenia coenurus* has been reported. Surgical excision was curative.<sup>35</sup>

## RATS, MICE, AND HAMSTERS

The retinas of rats, mice, and hamsters are holangiatic, with arteries and venules radiating from the optic nerve like spokes on a wheel.<sup>24,96</sup> Rats have three lacrimal glands: the intraorbital, extraorbital, and Harderian glands.

Inbred strains of rats and mice are commonly used in commercial laboratories to study naturally occurring ophthalmologic diseases. Diseases involving all parts of the eye have been described. Common abnormalities are retinal degeneration, as in the Royal College of Surgeons (RCS) rat strain<sup>85</sup>; microphthalmos; and cataracts. In addition to specific, genetically determined ocular abnormalities in inbred strains, other spontaneous abnormalities occur. Ophthalmic examination of 6000 Sprague-Dawley rats revealed a focal linear retinopathy in 3% and a fundic coloboma in 0.5%.<sup>37</sup> Spontaneous corneal degeneration has been described in Sprague-Dawley and Wistar rats,<sup>7</sup> and corneal dystrophy has been described in Fischer 344 rats.<sup>48</sup> Experimental infections also lead to ophthalmic abnormalities. Blepharitis with crust formation in the medial canthus and partial periocular alopecia were observed in mice experimentally infected with *Trypanosoma brucei*.<sup>80</sup>

Conjunctivitis in mice can be caused by numerous infectious agents, including *Pseudomonas aeruginosa*, *Pseudomonas pneumotropica*, *Salmonella* species, *Streptobacillus moniliformis*,

*Corynebacterium kutscheri*, Lancefield group C streptococci, *Mycoplasma pulmonis*, mousepox or ectromelia virus, Sendai virus, and lymphocytic choriomeningitis virus.<sup>6,40</sup> Bacteriologic culture and sensitivity testing may be indicated in individual rats and mice with persistent conjunctivitis. Epiphora in rats and mice can be caused by dental problems. Nasolacrimal duct obstruction can result from overgrowth or malocclusion of the incisors.

Chromodacryorrhea, or “red tears,” is red staining around the eyes seen in rats and mice. Inflammation of the Harderian gland causes secretion of tears pigmented with porphyrin. Sialodacryoadenitis virus is a highly contagious coronavirus that replicates in the respiratory tract epithelium, causing rhinotracheitis, bronchitis, and alveolitis. The virus also causes sialoadenitis of the submandibular and parotid salivary glands and necrotizing dacryoadenitis of orbital and Harderian lacrimal glands. Exophthalmos, epiphora, and keratoconjunctivitis may result. The infection usually resolves within 1 week in immunocompetent animals. In a study of athymic rats, infection persisted for more than 3 months, indicating that normal T-cell function is required for host defenses against the virus.<sup>95</sup> Infection with sialodacryoadenitis virus may also result in uveitis and multifocal retinal degeneration.<sup>40</sup> Complications from infection include corneal opacification, anterior and posterior synechiae, cataract, and glaucoma. Specific therapy is not available, and treatment is supportive only. Other causes for red tears are infection with parainfluenza virus type 3 or Sendai virus, as well as pain or stress. Ammonia vapor from soiled bedding can act as an ocular irritant, predisposing animals to secondary infection. Keeping the housing areas well ventilated is important in preventing infection with sialodacryoadenitis virus.



Of clinical significance is the effect of xylazine on the lens in rats and mice. A reversible cataract has been observed after systemic use of xylazine. Transcorneal water loss and altered aqueous humor composition caused by corneal exposure have been suggested as a pathogenesis of cataract formation.<sup>14</sup>

In hamsters, keratoconjunctivitis can result from ammonia vapor from soiled bedding. Dental problems including tooth root infection may result in facial or retrobulbar abscesses, with hemifacial swelling, proptosis, and exposure keratitis as common sequelae. Treatment with systemic antibiotics is often unrewarding, and such abscesses frequently lead to the animal's death.<sup>40</sup> A decrease in tear production was observed after systemic treatment with trimethoprim-sulfa for 14 days in hamsters.<sup>72</sup>

Insidious globe enlargement with loss of vision has been reported in four hamsters.<sup>22</sup> Ophthalmic examination of these hamsters revealed enlarged globes in both eyes, widely dilated pupils, lack of pupillary light reflex, a small optic nerve, and pale retinas. Histopathologic results suggested chronic open-angle glaucoma. Treatment of the suspected glaucoma was not attempted.

An intraocular signet-ring cell melanoma was diagnosed on histopathologic examination of an enucleated globe in a hamster. Enucleation was curative.<sup>46</sup>

## SUGAR GLIDERS

Sugar gliders have an avascular retina. Only a small residual tuft of fluorescein-impermeable vessels projects from the optic disk into the vitreous.<sup>13</sup>

Sugar gliders have prominent globes that are susceptible to trauma. Corneal ulcers may result from intraspecies fighting.<sup>69</sup> A retrobulbar abscess can result from a bite wound to the face or a molar root abscess (see [Chapter 27](#)). Corneal lipid infiltration may form in juvenile sugar gliders when the mother is fed a diet that is too high in fat. Although not reported, cataract formation is seen clinically.

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